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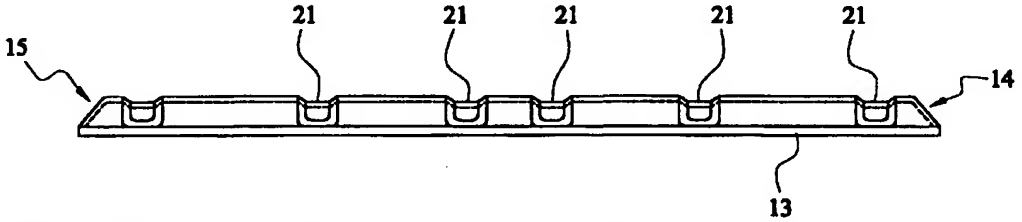
(54) Title: CONDENSER HEADERS



(57) Abstract: A header (2, 3) for a condenser (1) of a vehicle air conditioning system has longitudinally opposed closed ends and is formed of an aluminium alloy material tube plate (6) and tank piece (5) brazed together. The tube plate (6) includes tube receiving openings (8) spaced along the length of a spanning portion (7) of the tube plate (6), the spanning portion (7) being integral with a substantially continuous peripheral rim wall (9a, b, c, d). The tank piece (5) cooperates with the tube plate (6) in a nesting relationship to form the header (2, 3), the tank piece (5) having an arcuate shell wall following a radius of curvature and including side portions (13) overlapping respective opposed side walls (9a, b, c, d) of the tube plate (6). Integrally formed with the tank piece (5) shell wall side portions are opposed end walls (14, 15) overlapping respective end rim walls (9c, 9d) of the tube plate (6). The opposed closed ends of the header (2, 3) is defined by the overlapping end walls of the tube plate (6) and end walls of the tank piece (7).

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Condenser Headers

The present invention relates to condenser headers and in particular to condenser headers for vehicle air conditioning systems.

Condensers for vehicle air conditioning systems typically comprise cylindrical (or substantially cylindrical) headers closed by end caps. Typically the end caps are brazed to close the ends of the headers. The cylindrical construction is seen as providing an optimum 'pressure vessel' for high pressure systems such as refrigeration circuits.

In this respect condensers are seen in the art as high pressure heat exchangers and distinct from lower pressure heat exchangers such as vehicle radiators. Techniques for manufacturing radiators are typically seen as not suitable for use in condenser manufacture due to the much higher pressure and pressure cycling requirements for condensers.

A two piece condenser header has been proposed and such a construction is disclosed in, for example, US-A-5994096. An improved construction has now been devised.

According to a first aspect of the invention, there is provided a header for a condenser of a vehicle air conditioning system, the header having longitudinally opposed closed ends and comprising:

a tube plate including a plurality of tube receiving openings spaced along the length of a spanning portion of the tube plate, the spanning portion being integral with a substantially continuous peripheral rim wall arrangement upstanding from the spanning portion, the rim wall arrangement including opposed side wall rim portions and opposed end wall rim portions; and,

a tank piece cooperating with the tube plate in a nesting relationship to form the header, the tank piece comprising an arcuate shell wall following a radius of curvature and including side portions overlapping respective opposed side wall rim portions of the tube plate and, integrally formed with the tank piece shell wall side portions, opposed end walls overlapping respective end wall rim portions of the tube plate, the opposed closed ends of the header including the overlapping end wall portions of the tube plate and end walls of the tank piece.

The construction provides that separate end walls secured at opposed ends of the header are not required, the end walls being defined by the overlapping end portions of the tank plate and tube piece. This has manufacturing benefits in terms of reduced number of components required and shorter assembly time needed. The arcuate shell wall which is typically of a radius of curvature throughout a substantial majority of its span also provides good pressure vessel characteristics. Other benefits also result and these will be explained hereafter.

The tube plate and/or the tank piece are preferably press formed metallic components. Typically the tube plate and the tank piece comprise aluminium material, the components being brazed together following assembly to form a unitary header. The tube plate and tank piece are preferably formed of aluminium material clad with a fusible brazing alloy. The use of such material is well known in the art and the header interconnecting heat exchange fluid containing tubes of condensers are typically also formed of such material to permit one-shot brazing of assembled (and mechanically secured) condenser components.

The tube plate and the tank plate are sealed (brazed) in the region of respectively overlapping portions.

Mechanical securing means is provided is preferably to hold the tank piece and the tube plate for sealing/brazing. The mechanical securing means preferably comprises one or more securing elements Typically deformable tabs) integral with the tank piece or tube plate and deformable relative thereto to hold the other of the tank piece or tube plate prior to brazing. The securing element is preferably deformable into a receiving formation on the other of the tank piece or tube plate.

The tank piece is preferably received nested within the wall rim portions of the tube plate. The side wall and end wall rim portions of the tube plate beneficially have terminal portions splayed outwardly to provide a lead-in opening accommodating nesting of the tank piece.

The tank piece shell wall preferably has a concavely curved internal wall surface. This gives good pressure vessel characteristics. Most preferably the tank piece shell wall has an arcuate internal wall surface.

The spanning portion of the tube plate is preferably less curved than the concavely curved portion of the tank piece shell wall internal surface. The spanning portion of the tube plate has a substantially flat spanning portion or a portion approximating a substantially flat portion. Such a construction has been shown to reduce overall header dimensions but retain good pressure vessel characteristics. Reduction of the size of components is of great benefit in vehicle technology due to the premium placed upon space in vehicle engine compartments. Reduced width headers permit a condenser of the same overall dimensions to have increased length connecting heat exchange tubes increasing the heat transfer performance for a condenser of given overall dimensions. The brazed seal between the tank piece and the tube plate around the entire periphery of the header gives high structural integrity to the manufactured header.

The tank piece shell preferably has a curved wall portion and is received nested in the tube plate peripheral rim wall arrangement, the depth of the tank piece being greater than the depth of the tube plate.

The tank piece shell end walls preferably include respective opposed sloping nose end portions each positioned between a raised profile portion of the shell

wall and leading to a respective terminal end wall shoulder. The sloping nose ends provide good pressure withstanding capabilities, and enable the prior art use of separate end pieces to be avoided. The nose end sloping portions preferably include a thumbnail configured sloping portion.

The tank piece shell wall is preferably formed to have at least one (preferably a plurality/series) of external profile steps; this enhances structural rigidity and improves pressure vessel characteristics. One or more external recesses or depressions may receive securing tabs carried by the tube plate. One or more internal formations preferably locate internal header dividing pieces.

According to a further aspect, the invention provides a header for a condenser of a vehicle air conditioning system, the header comprising:

a tube plate including a plurality of tube receiving openings spaced along the length of a spanning portion of the tube plate; and

a tank piece bonded with the tube plate to form the header;

wherein the tube plate includes respective longitudinally running sloping or curved shoulder portions provided at respective margins of the spanning portion of the tube plate, and wherein the tube receiving openings intersect with the shoulder

portions.

Preferably, the shoulder portions include a convex external surface zone and a concave external surface zone adjacent the convex zone. The tube receiving openings preferably intersect within the convex zone, or the concave zone, or the changeover zone between the convex and concave zones.

Beneficially, the surface contact length between the external longitudinal edge surface of the heat exchange tube and the tube receiving opening at the shoulder portion is greater than the gauge thickness of the material of the tube plate. This provides increased contact for brazing/bonding.

According to a further aspect, the invention provides a method of manufacturing a vehicle air conditioning condenser header according to the first aspect of the invention, the method comprising:

nesting the tube plate and tank piece;

deforming securing tabs to hold the tank piece and tube plate as an assembly;

brazing the assembly in a brazing operation to form a peripheral bond between the tube plate and tank piece, including a brazed connection between the tank piece and tube plate defining sealed ends of the header.

The assembly will include other condenser components such

as heat exchange tubes extending between a pair of such headers in the assembly.

According to a further aspect, the invention provides a condenser for a vehicle air conditioning system, the condenser comprising a plurality of headers as defined herein and, interconnecting the headers, a series of stacked heat exchange tubes, each communicating through respective tube receiving openings in the respective tube plates of respective headers.

The invention will now be further described in a specific embodiment by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a schematic side view of an exemplary condenser according to the invention utilising a pair of headers according to the invention;

Figure 2 is a plan view of a tube plate of the header shown in Figure 1;

Figure 3 is an end view of the tube plate of Figure 2;

Figure 4 is a side view of the tube plate of Figures 2 and 3;

Figure 5 is a sectional view along AA in Figure 2;

Figure 6 is a sectional view along CC in Figure 2;

Figure 7 is a sectional view along EE in Figure 2;

Figure 8 is a plan view of the tank piece of the header of Figure 1;

Figure 9 is an end view of the tank piece of Figure 8;

Figure 10 is a side view of the tank piece of Figure 8;

Figure 11 is a section along AA in Figure 8;

Figure 12 is a section along CC in Figure 8;

Figure 13 is a plan view of a divider inserted between the nested tank piece of Figure 8 and tube plate of Figure 2;

Figure 14 is a side view of the divider of Figure 13;

Figure 15 is a plan internal-side view of a tube plate of an alternative embodiment of a header according to the invention;

Figure 16 is an end view of the tube plate of Figure 15;

Figure 17 is a side view of the tube plate of Figures 15 and 16;

Figure 18 is a partial sectional view of a header in accordance with the alternative embodiment according to the invention; and

Figure 19 is a transverse sectional view of the tube plate of Figures 15 to 18.

Referring to the drawings, and initially to Figure 1, there is shown a condenser (generally designated 1) for use in a vehicle air conditioning system. Condenser 1 includes a pair of spaced headers 2, 3 and, connecting spaced headers 2, 3, a series of stacked heat exchange tubes 4 which, in use contain system refrigerant. The condenser assembly is generally of brazed aluminium construction, the constituent components being brazed in a 'one-shot' brazing operation.

Each header 2, 3 comprises a tank piece 5, brazed to (and nested within) a tube plate 6 the construction and nature of which will be described in detail hereafter. The coolant containing tubes 4 extend into the interior of headers 3 in a manner as will be described in greater detail hereinafter also.

Both the tube plate 6 and tank piece 5 are formed in a pressing process and comprise relatively high strength aluminium core sheet/strip (modified A3003 aluminium alloy for example) which is clad with a fusible aluminium brazing alloy. The use of brazing alloy clad aluminium is known for brazed aluminium components used in the art.

Tube plate 6 has a spanning portion 7 having a header internal surface slightly concavely formed to have an slightly arcuate internal surface having a centre of curvature of radius of 50 mm. This surface therefore approximates to a substantially flat surface; this is shown

most clearly in Figure 5.

A series of spaced plunging apertures 8 are formed through spanning portion 7, the configuration being shown most clearly in Figures 6 and 7. The plunging apertures 8 receive heat exchange tubes extending therethrough and are secured/sealed during the one-shot brazing process.

Upstanding from spanning portion 7 of tube plate 6 is a substantially continuous peripheral rim wall arrangement including opposed side wall rim portions 9a, 9b and opposed end wall rim portions 9c, 9d. The peripheral rim wall arrangement of the tube plate 6 is formed during the pressing operation.

As shown most clearly in Figures 5 and 7, side wall rim portions 9a, 9b and end wall rim portions 9c, 9d are tapered outwardly at their terminal margins to provide a 'lead-in' 10 at an angle or 30° into the space between side walls 9a, 9b and end walls 9c, 9d. The 'lead-in' 10 aids in assembling the tank piece 5 in nesting relationship with the tube plate 6. The outwardly splayed 'lead-in' portion 10 of side walls 9a, 9b is interrupted to define a series of clenching tabs 11 which are used to mechanically secure tank piece 5 in nested relationship with tube plate 6 prior to brazing. The clenching tabs are deformed to engage the outer surface of the nested tank piece 5 in recesses 21.

Referring additionally now to Figures 8 to 12 showing the tank piece 5, it is shown that the tank piece 5 comprises an internal surface profile along its length arcuately

formed (during the pressing process) to have a radius of curvature of 11 mm, which curved profile extends around, and defines, substantially the entire depth of the tank piece 5. The arcuate internal surface 12 of tank piece 5 leads to a terminal marginal rim 13 which extends around the entire periphery of tank piece 5 and in use lies adjacently in contact with the internal surfaces of wall rim portions 9a, 9b, 9c and 9d of tube plate 6. The arcuate internal surface 12 of the tank piece 5 provides high pressure strength and therefore good pressure vessel characteristics.

The tank piece 5 is press formed to have opposed end formations 14, 15 in the form of inclined, snub-nosed walls having 'thumbnail' shaped portions inclined extending slopingly downwardly from the radially outer most portion of the arcuate outer shell of tank piece 5, leading to respective opposed end rims 13a, 13b.

Upon assembly of tank piece 5 in nesting relationship with tube plate 6, the snub-nosed portions 14, 15, in combination with rim wall portions 9c, 9d of tube plate 6, effectively provide closed opposed ends for the header, avoiding the requirement to have separate end caps as is the case for prior art constructions. When the assembly is brazed in the one-shot brazing operation, a continuous brazed connection/seal is provided around the contacting adjacent periphery of tank piece 5 (rim 13) and the internal wall surface of rim wall arrangement 9a, 9b, 9c, 9d of tube plate 6.

The angled sloping surface portion of snub-nosed portions 14, 15 provides good pressure vessel characteristics to withstand the pressures encountered in refrigeration system condensers in automotive use.

The tank piece 5 is press formed to have a series of profiled step recesses 21. These aid in enhancing the overall rigidity and structural integrity of the header, and also may accommodate the clenching tabs 11 which are folded over to be received in recesses 21.

The interior of the header is divided into flow sections utilising a divider 23 as shown in Figures 13 and 14. The divider has a locator projection 24 which is received in a slot 25 provided in the tank piece 5.

Tank piece 5 is provided with an aperture for connection to a fluid line or connector block to permit entry or exit of the refrigerant into the header.

Referring now to the embodiment shown in Figures 15 to 19, the overall construction is generally similar to the embodiment shown in Figures 1 to 14. The main difference is in respect of tube plate 106 which is provided with a pair of spaced longitudinally running shoulder formations 120, 121 either side of spanning portion 107. The shoulder formations 120, 121 include a convex external surface zone 130, a concave external surface zone 131 and a changeover zone 132. The shoulder portions 120, 121 are intersected by plunging apertures 108 (at the convex shoulder zone 130) such that the tube 104 when received in tube plate 106

passes through respective shoulder formation 120, 121. The longitudinally running edges of tubes 104 therefore intersect substantially non-perpendicular with the wall of tube plate 106 providing a greater contact area between the longitudinally running edges of tube 104 and tube plate 106 (dimension Y in Figure 18). This enhances the brazing area contact and provides for greater integrity when brazed to withstand high internal pressures.

Additionally, the longitudinally running shoulders 120, 121 provide structural rigidity to the tube plate 106 which again enables the arrangement to withstand high internal pressures and pressure cycles. The arcuate curved surface 112 of tank piece 105 (as mentioned earlier) provides good pressure vessel characteristics enabling the brazed condenser header to withstand high internal pressures and pressure cycling. Because the plunging apertures 108 intersect with shoulders 121 and 120, the edges of the plunging apertures are visible in Figure 17. The shoulder formations 120, 121 shown in Figure 18 are exemplary only, and other shoulder configurations may provide similar benefits. The importance here is to provide added rigidity to the tube plate 106 and also provide the greater brazing surface area contact with the tube 104.

Claims:

1. A header for a condenser of a vehicle air conditioning system, the header having longitudinally opposed closed ends and comprising:

a tube plate including a plurality of tube receiving openings spaced along the length of a spanning portion of the tube plate, the spanning portion being integral with a substantially continuous peripheral rim wall arrangement upstanding from the spanning portion, the rim wall arrangement including opposed side wall rim portions and opposed end wall rim portions; and,

a tank piece cooperating with the tube plate in a nesting relationship to form the header, the tank piece comprising an arcuate shell wall following a radius of curvature and including side portions overlapping respective opposed side wall rim portions of the tube plate and, integrally formed with the tank piece shell wall side portions, opposed end walls overlapping respective end wall rim portions of the tube plate, the opposed closed ends of the header including the overlapping end wall portions of the tube plate and end walls of the tank piece;

the tube plate and tank piece being of aluminium alloy material and brazed to form the header.

2. A header according to claim 1, wherein the spanning portion of the tube plate is:

a) substantially flat; or

b) of a radius of curvature substantially greater than the radius of curvature of the arcuate shell tank piece.

3. A header according to claim 1 or claim 2, wherein the tube plate includes a series of spaced openings for receiving heat exchange tubes, a respective sloping or curved shoulder portion being provided extending longitudinally of the tube plate at the margins of the spanning portion of the tube plate, the tube receiving openings intersecting the shoulder portions.

4. A header according to claim 3, wherein the shoulder portions include a convex external surface zone adjacent a concave external surface of the tube plate.

5. A header according to claim 2 or claim 3, wherein the surface contact length between the external longitudinal edge surface of the heat exchange tube and the tube receiving opening at the shoulder portion is greater than the gauge thickness of the material of the tube plate.

6. A header according to any preceding claim, wherein the tank piece shell end walls include respective opposed

sloping nose end portions each positioned between a raised profile portion of the shell wall and leading to a respective terminal end wall shoulder.

7. A header according to claim 6, wherein the respective nose end sloping portions include a thumbnail configured sloping portion.

8. A header according to any preceding claim, wherein the tube plate and/or the tank piece are press formed components.

9. A header according to any preceding claim, wherein the tube plate and the tank plate are brazed sealed in the region of respectively overlapping portions.

10. A header tank according to any preceding claim wherein mechanical securing means is provided to hold the tank piece and the tube plate for sealing/brazing.

11. A header according to claim 10, wherein the mechanical securing means comprises one or more securing elements integral with the tank piece or tube plate and deformable relative thereto to hold the other of the tank piece or tube plate.

12. A header according to claim 11, wherein the securing element is deformed into a receiving formation on the other of the tank piece or tube plate.

13. A header according to any preceding claim, wherein the tank piece is received nested within the wall rim portions of the tube plate.

14. A header according to claim 13, wherein the side wall and end wall rim portions of the tube plate have terminal portions splayed outwardly to provide a lead-in opening accommodating nesting of the tank piece.

15. A header according to any preceding claim, wherein the tank piece shell wall has a concavely curved internal wall surface.

16. A header tank according to any preceding claim, wherein the spanning portion of the tube plate has a substantially flat spanning portion or a portion approximating a substantially flat portion.

17. A header according to any preceding claim, wherein the tank piece shell has a concavely curved wall portion and is received nested in the tube plate peripheral rim wall arrangement.

18. A header according to any preceding claim, wherein the tank piece shell wall is formed to have a series of profile steps enhancing the strength of the tank piece.

19. A method of manufacturing a vehicle air conditioning condenser header according to any preceding claim, the method comprising:

nesting the tube plate and tank piece;

deforming securing tabs to hold the tank piece and tube plate as an assembly;

brazing the assembly in a brazing operation to form a peripheral bond between the tube plate and tank piece, including a brazed connection between the tank piece and tube plate defining sealed ends of the header.

20. A condenser for a vehicle air conditioning system, the condenser comprising a pair of headers according to any preceding claim and, interconnecting the headers a series of stacked heat exchange tubes, each communicating through respective tube receiving openings in the respective tube plates of respective headers.

21. A header for a condenser of a vehicle air conditioning system, the header comprising:

a tube plate including a plurality of tube receiving openings spaced along the length of a spanning portion of the tube plate; and

a tank piece bonded with the tube plate to form the header;

wherein the tube plate includes respective

longitudinally running sloping or curved shoulder portions provided at respective margins of the spanning portion of the tube plate, and wherein the tube receiving openings intersect with the shoulder portions.

22. A header according to claim 21, wherein the shoulder portions include a convex external surface zone adjacent a concave external surface zone.

23. A header according to claim 21 or claim 22, wherein the surface contact length between external longitudinal edge of the condenser tube and the tube receiving opening at the shoulder portion is greater than the gauge thickness of the material of the tube plate.

24. A condenser for a vehicle air conditioning system, the condenser comprising a pair of headers according to any preceding claim and, interconnecting the headers a series of stacked heat exchange tubes, each communicating through respective tube receiving openings in the respective tube plates of respective headers.

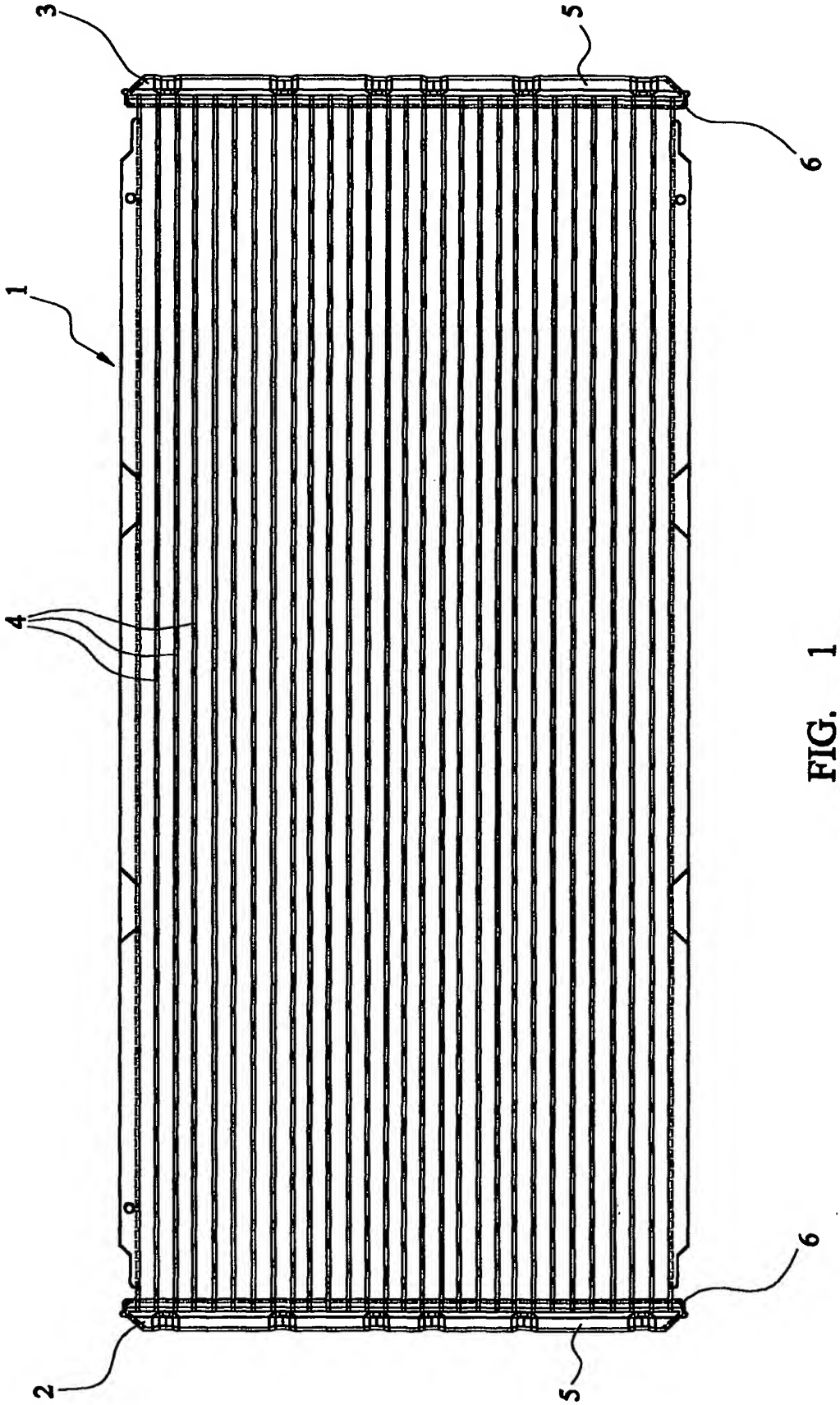


FIG. 1

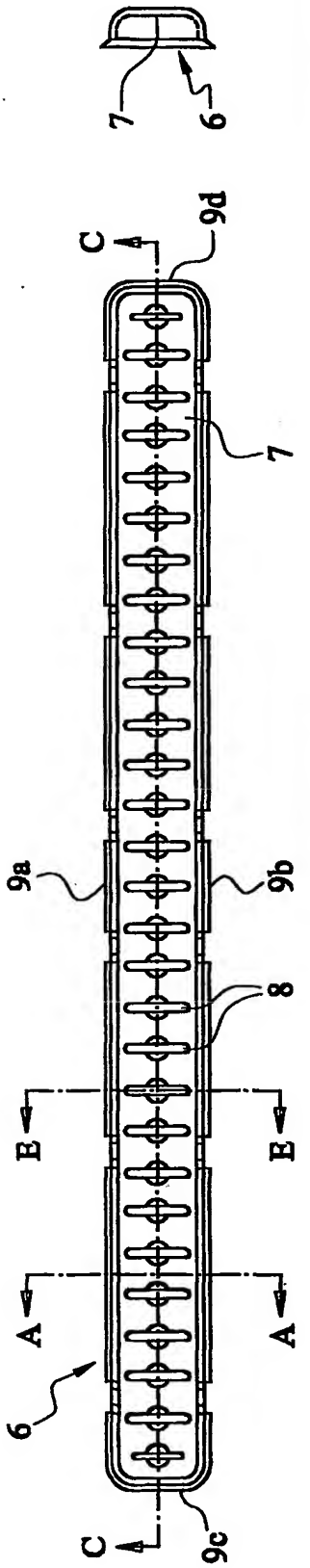


FIG. 2

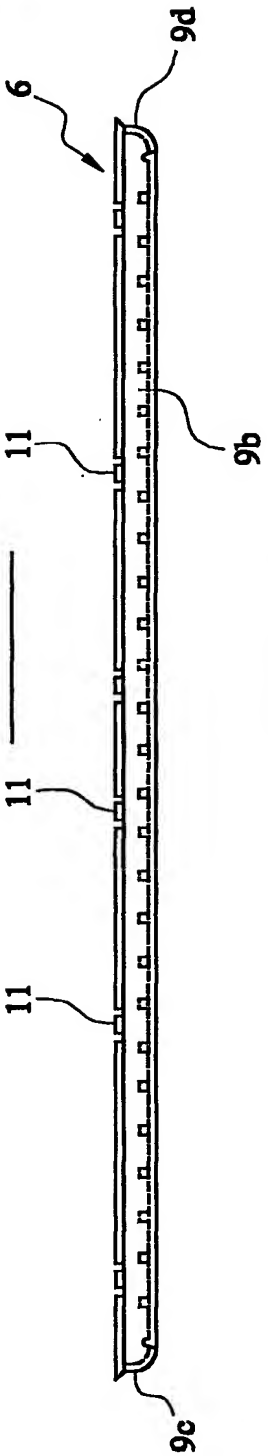


FIG. 3

FIG. 4

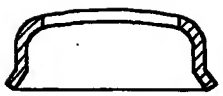


FIG. 5

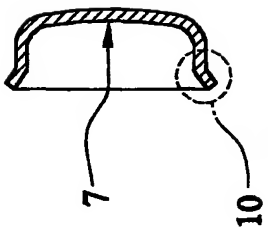


FIG. 6

FIG. 7

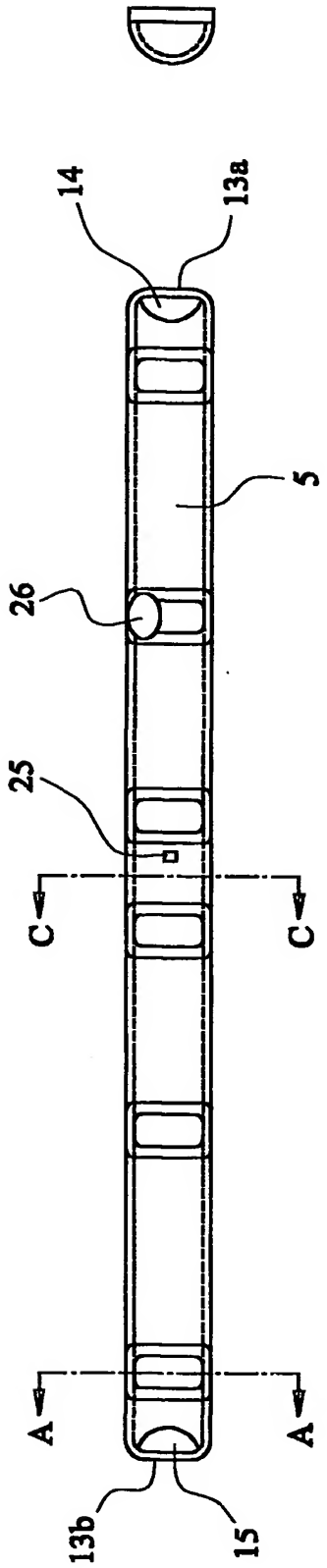


FIG. 8

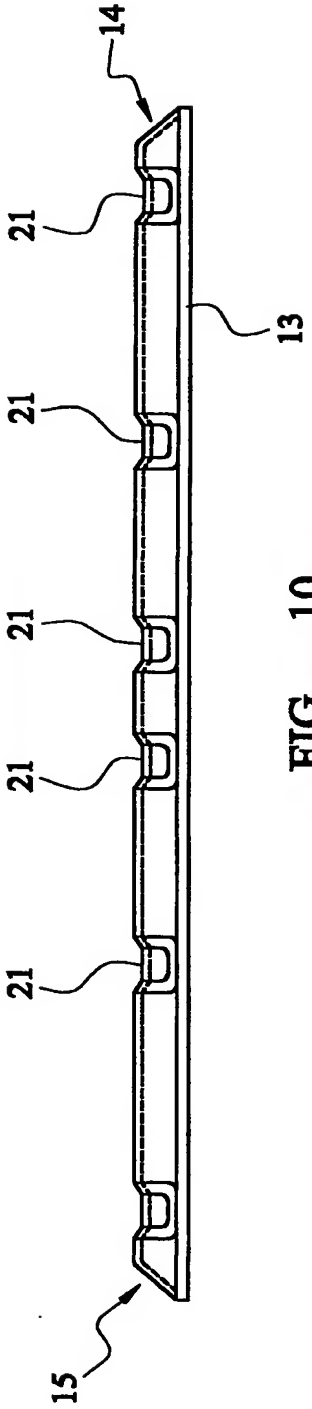


FIG. 10

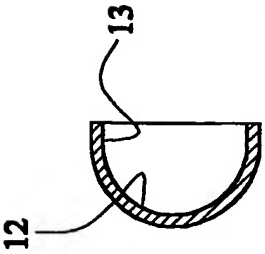


FIG. 12

FIG. 11

FIG. 9

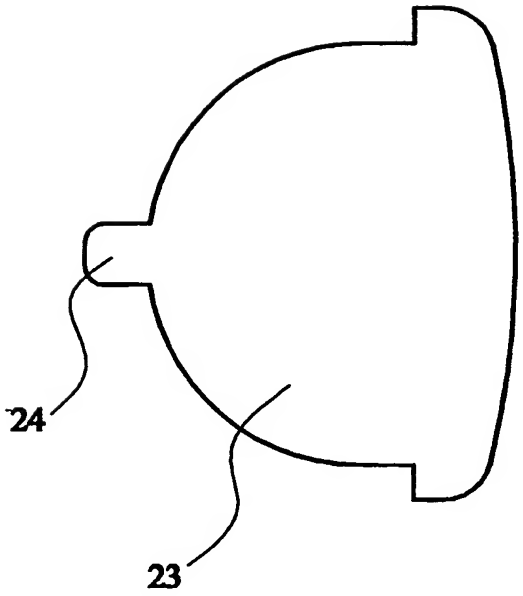


FIG. 13

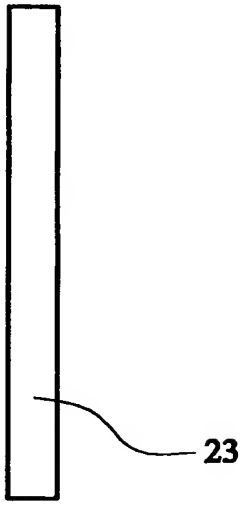


FIG. 14

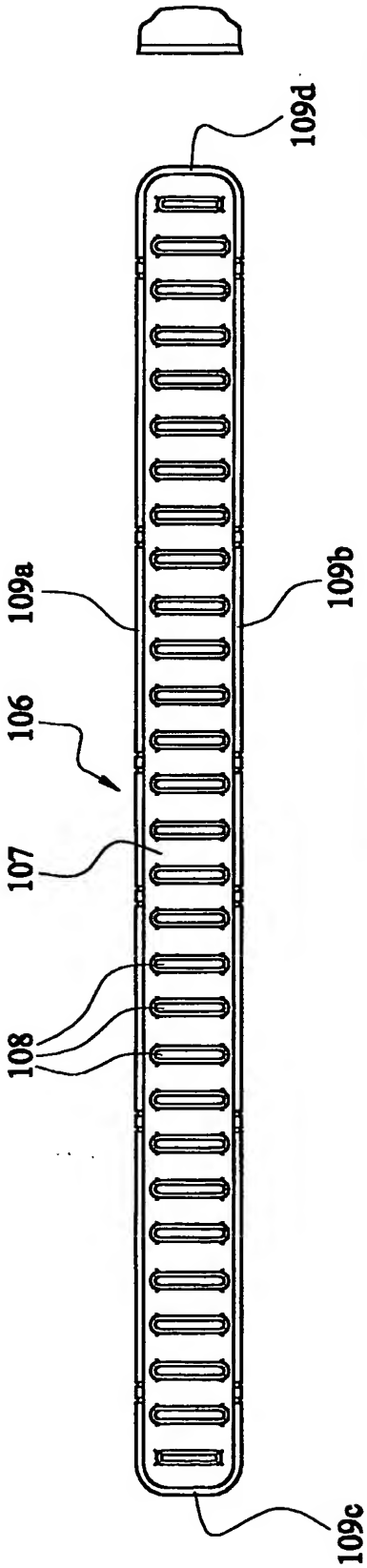


FIG. 15

FIG. 16

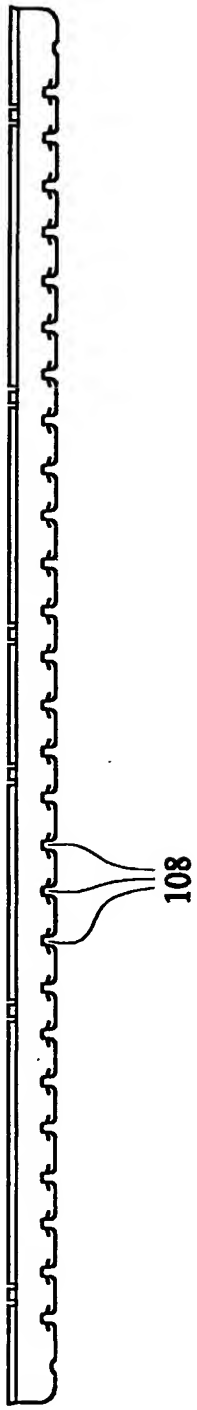
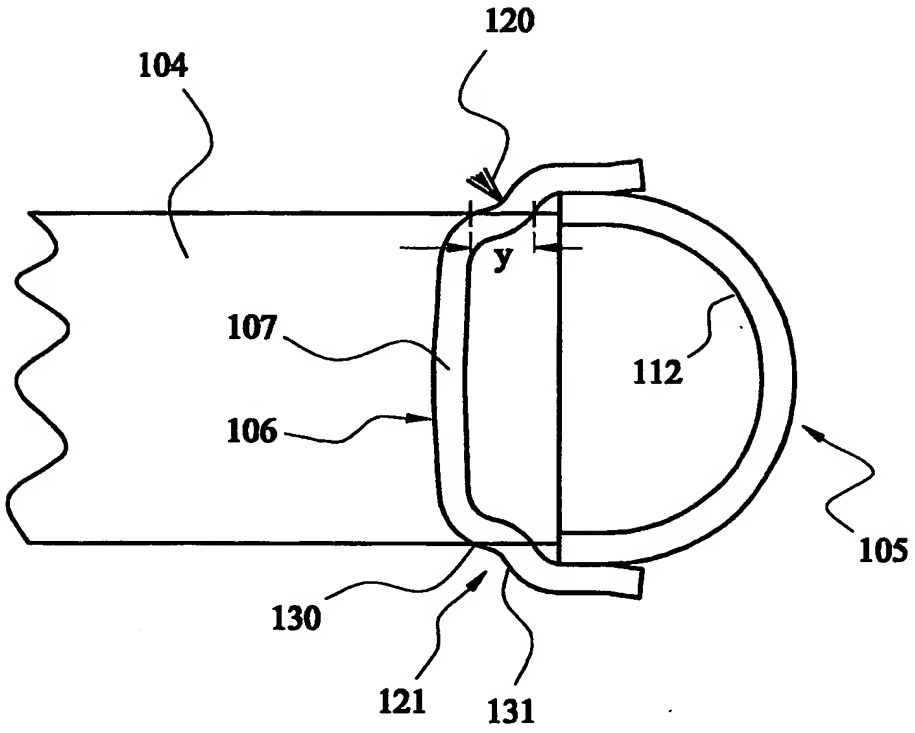


FIG. 17


120
104
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107
112
106
105
130
121
131

FIG. 18

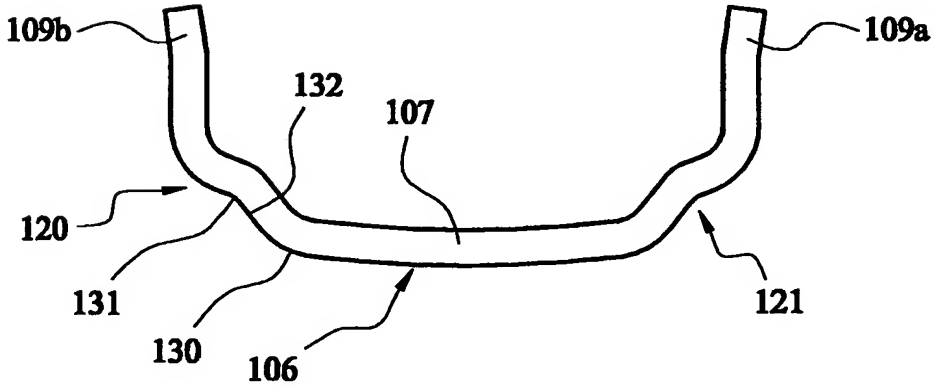
109b
109a
132
107
120
131
130
106
121

FIG. 19

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 01/03025

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F28F9/02 F28D1/053

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F28F B60H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 651 221 A (MODINE MFG CO) 3 May 1995 (1995-05-03)	1,2,8,9, 13, 15-17, 20,24
Y	column 3, line 51 -column 5, line 26; figures	3,5,10, 11,14, 18,19
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A	column 6, line 46 -column 7, line 3; figures 10A,B,C	4,21-23
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2001	09/11/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Van Dooren, M

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INTERNATIONAL SEARCH REPORT

Int ~ ional Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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